

# THE PALOMAR TRANSIENT FACTORY PHOTOMETRIC CATALOG 1.0

E. O. OFEK<sup>1</sup>, R. LAHER<sup>2</sup>, J. SURACE<sup>2</sup>, D. LEVITAN<sup>3</sup>, B. SESAR<sup>3</sup>, A. HORESH<sup>3</sup>, N. LAW<sup>4</sup>, J. C. VAN EYKEN<sup>5</sup>, S. R. KULKARNI<sup>3</sup>, T. A. PRINCE<sup>3</sup>, P. NUGENT<sup>6</sup>, M. SULLIVAN<sup>7</sup>, O. YARON<sup>1</sup>, A. PICKLES<sup>8</sup>, M. AGÜEROS<sup>9</sup>, I. ARCAVI<sup>1</sup>, L. BILDSTEN<sup>10,11</sup>, J. BLOOM<sup>12</sup>, S. B. CENKO<sup>12</sup>, A. GAL-YAM<sup>1</sup>, C. GRILLMAIR<sup>2</sup>, G. HELOU<sup>2</sup>, M. M. KASLIWAL<sup>1</sup>, D. POZNANSKI<sup>13</sup>, R. QUIMBY<sup>14</sup>

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## ABSTRACT

We construct a photometrically calibrated catalog of non-variable sources from the Palomar Transient Factory (PTF) observations. The first version of this catalog presented here, the PTF photometric catalog 1.0, contains calibrated  $R_{\text{PTF}}$ -filter magnitudes for  $\approx 2.1 \times 10^7$  sources brighter than magnitude 19, over an area of  $\approx 11233 \text{ deg}^2$ . The magnitudes are provided in the PTF photometric system, and the color of a source is required in order to convert these magnitudes into other magnitude systems. We estimate that the magnitudes in this catalog have typical accuracy of about 0.02 mag with respect to magnitudes from the Sloan Digital Sky Survey. The median repeatability of our catalog's magnitudes for stars between 15 and 16 mag, is about 0.01 mag, and it is better than 0.03 mag for 95% of the sources in this magnitude range. The main goal of this catalog is to provide reference magnitudes for photometric calibration of visible light observations. Subsequent versions of this catalog, which will be published incrementally online, will be extended to a larger sky area and will also include  $g_{\text{PTF}}$ -filter magnitudes, as well as variability and proper motion information.

*Subject headings:* techniques: photometric – catalogs

## 1. INTRODUCTION

All-sky photometrically-calibrated stellar catalogs are being used to measure the true apparent flux of astrophysical sources. Other approaches, like observing standard stars (e.g., Landolt 1992), are time consuming since they require additional observations (which are not of the source of interest) under photometric conditions. Therefore, it is desirable to have an all-sky catalog that contains calibrated stellar magnitudes. To date, the most widely used catalog for this purpose is probably the USNO-B1.0 (Monet et al. 2003), which provides the blue, red and near infra-red photographic plate magnitudes for about  $10^9$  sources. Unfortunately, the photometric measurements in the USNO-B1 catalog show significant systematic variations in the magnitude zeropoint as a function of the position on the sky ( $\sim 0.5$  mag), even at small angular

scales (Sesar et al. 2006).

The Sloan Digital Sky Survey (SDSS) is calibrated to an accuracy of better than 2% (Adelman-McCarthy et al. 2008; Padmanabhan et al. 2008). However, SDSS Data Release 8 covers only about a third of the celestial sphere. Another possibility is to use bright Tycho-2 (Høg et al. 2000) stars to photometrically calibrate images (Ofek 2008; Pickles & Depagne 2010). However, this approach requires that the Tycho stars, brighter than magnitude  $\approx 12$ , are not saturated in the images.

The Palomar Transient Factory<sup>15</sup> (PTF; Law et al. 2009; Rau et al. 2009) is a synoptic survey designed to explore the transient sky and to study stellar variability. The project utilizes the 48" Samuel Oschin Schmidt Telescope at Palomar Observatory. The telescope has a digital camera equipped with 11 active CCDs<sup>16</sup>, each  $2K \times 4K$  pixels (Rahmer et al. 2008), and has been surveying the northern sky since March 2009. Each PTF image covers  $7.26 \text{ deg}^2$  with a pixel scale of  $1.01'' \text{ pix}^{-1}$ . The median point-spread function full-width at half maximum is  $\approx 2''$  and it is uniform over the camera field of view (Law et al. 2010). The PTF main survey is currently performed in the  $g$  band during dark time and in the Mould  $R$  band during bright time, but most of the data taken prior to January 2011 were obtained using the  $R$ -band filter. In addition, a few nights around times of full Moon are used for surveying the sky with narrow-band  $H\alpha$  filters. An overview of the PTF survey and its first-year performance is given in Law et al. (2010).

The PTF data are reduced by pipelines running at Caltech's Infrared Processing and Analysis Center (IPAC). The processing includes astrometric and photometric calibration. Here we build on the PTF photometric calibration to construct a catalog of calibrated non-variable sources. This catalog can be used to photometrically calibrate other visible-light observations.

<sup>1</sup> Benozziyo Center for Astrophysics, Weizmann Institute of Science, 76100 Rehovot, Israel.

<sup>2</sup> Spitzer Science Center, MS 314-6, California Institute of Technology, Pasadena, CA 91125, USA

<sup>3</sup> Division of Physics, Mathematics and Astronomy, California Institute of Technology, Pasadena, CA 91125, USA

<sup>4</sup> Dunlap Institute for Astronomy and Astrophysics, University of Toronto, 50 St. George Street, Toronto, Ontario M5S 3H4, Canada.

<sup>5</sup> NASA Exoplanet Science Institute, California Institute of Technology, 770 South Wilson Avenue, M/S 100-22, Pasadena, CA, 91125, USA

<sup>6</sup> Department of Astronomy, University of California, Berkeley, Berkeley, CA 94720-3411.

<sup>7</sup> Department of Physics, University of Oxford, Denys Wilkinson Building, Keble Road, Oxford OX1 3RH, UK.

<sup>8</sup> Las Cumbres Observatory Global Telescope Network, Santa Barbara, CA 93117

<sup>9</sup> Columbia University, Department of Astronomy, 550 West 120th street, New York, NY 10027

<sup>10</sup> Department of Physics, Broida Hall, University of California, Santa Barbara, CA 93106.

<sup>11</sup> Kavli Institute for Theoretical Physics, Kohn Hall, University of California, Santa Barbara, CA 93106.

<sup>12</sup> Department of Astronomy, University of California, Berkeley, Berkeley, CA 94720-3411.

<sup>13</sup> School of Physics and Astronomy, Tel-Aviv University, Israel

<sup>14</sup> IPMU, University of Tokyo, 5-1-5 Kashiwanoha, Kashiwa-shi, Chiba, 277-8583, Japan

<sup>15</sup> <http://www.astro.caltech.edu/ptf/>

<sup>16</sup> The camera has 12 CCDs of which one is not functional.

The paper is organized as follows. In §2, we briefly discuss the PTF photometric calibration. The construction of the photometric catalog is described in §3. The catalog is presented in §4 and we discuss its accuracy and repeatability in §5. Finally we conclude in §6.

## 2. BRIEF DESCRIPTION OF THE PTF PHOTOMETRIC CALIBRATION

Here we briefly describe the photometric calibration of the PTF images, which is fundamental to the construction of the PTF photometric catalog. A full description can be found in Ofek et al. (2012).

We use images reduced by the IPAC-PTF pipeline (Grillmair et al. 2010; Laher et al., in prep.). The processing includes splitting the multi-extension FITS images, de-biasing, flat-fielding, astrometric calibration, generation of mask images, source extraction, and photometric calibration. The astrometric calibration is performed relative to SDSS when possible and the UCAC-3 catalog (Zacharias et al. 2010) when SDSS information is not available. If a UCAC-3 solution is not found, then the astrometry is solved against USNO-B1.0 (Monet et al. 2003). The median astrometric rms in single axis is  $0.11''$ ,  $0.13''$  and  $0.4''$ , for the SDSS, UCAC-3 and USNO-B1.0 catalogue, respectively. The masks flag pixels with image artifacts, including ghosts, halos, aircraft/satellite tracks, saturation, CCD bleeding, and dead/bad pixels. Sources which contain masked pixels inherit the pixels' flag, and these are stored in the catalogs associated with the processed images.

Our photometric calibration method is similar to the classical method of observing standard stars through various airmasses and assuming photometric conditions – i.e., the atmospheric transmission properties are constant in time and are a continuous function of airmass. On average, we typically observe  $\sim 10^5$  SDSS stars with high signal-to-noise ratio (S/N) per CCD per night. Therefore, we usually have a sufficient number of photometric measurements to robustly constrain all calibration parameters for a given night.

After selecting high S/N sources, we fit the difference between the instrumental magnitude measured in the PTF system (e.g.,  $R_{\text{PTF}}^{\text{inst}}$ ), and the standard star magnitudes measured by SDSS (e.g.,  $r_{\text{SDSS}}$ ) with a simple model. The free parameters in this model include the global zero point of the image, color term, extinction coefficient, color-airmass term, variation of the global zero point during the night, exposure time, and the illumination correction. Here the illumination correction represents variation of the photometric zero point as a function of position on the CCD. The latter correction is represented by two methods relative to the center of each CCD, which are described in Ofek et al. (2012). To generate the first version of the PTF photometric catalog, we use the model in which the variation of the photometric zero point with CCD position is a two-dimensional, low-order polynomial in the position across each CCD (i.e., Eq. 3 in Ofek et al. 2012). The goodness of the fit is described by several estimators, including the RMS of residuals of bright stars from the best fit model (parameter APBSRMS in Table 2 in Ofek et al. 2012).

We note that the magnitudes produced by our calibration process are related to the SDSS magnitude system (and other systems) via the aforementioned color terms. In the case where the  $r-i$  color of an object is known, it is possible to convert the PTF  $R$ -band magnitudes to other systems. These transformations are described in Ofek et al. (2012; Eqs. 4–

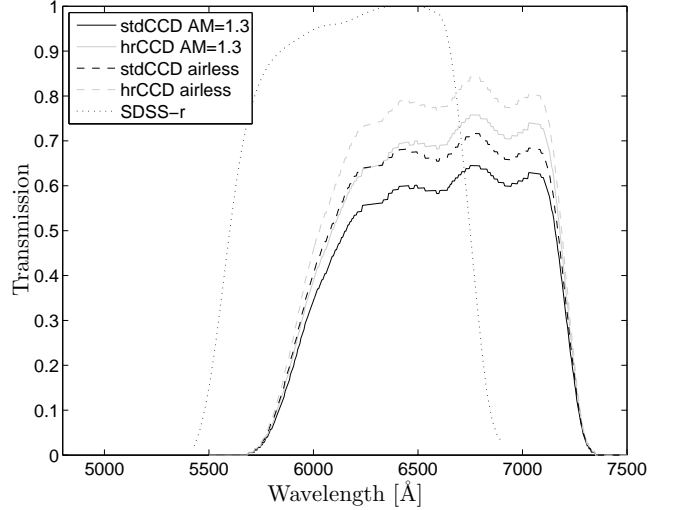


FIG. 1.— PTF  $R$ -band filter transmission at airmass of 1.3 (solid line) and no atmosphere (dashed line). The transmission is shown for the two CCD types in the PTF camera. ‘std’ stands for the standard CCD (black line; CCDID 0,1,2,6,7,8,9,10,11) while ‘hr’ stands for the high resistivity CCDs (gray line; CCDID 4,5). The transmission was calculated by multiplying the filter, CCD and atmospheric transmissions. The atmospheric transmission was calculated using a standard smooth atmosphere (Hayes & Latham 1975) for 1.7 km elevation and airmass 1.3. For reference we also show the transmission of the SDSS  $r$ -band filter.

TABLE 1  
PTF  $R$ -BAND FILTER TRANSMISSION

$\lambda$ Å	Filter	QE <sub>std</sub>	QE <sub>hr</sub>	Atm.	Sys <sub>std</sub>	Sys <sub>hr</sub>
5680.0	0.00	0.66	0.74	0.84	0.00	0.00
5685.0	0.00	0.66	0.74	0.84	0.00	0.00
5690.0	0.01	0.66	0.74	0.84	0.01	0.01
5695.0	0.01	0.66	0.75	0.84	0.01	0.01
5700.0	0.01	0.67	0.75	0.84	0.01	0.01

NOTE. — PTF  $R$ -band filter transmission (see also Figure 1).  $\lambda$  is the wavelength, ‘Filter’ is the filter transmission, ‘QE’ is the CCD efficiency, ‘Atm.’ is the atmosphere transmission calculated using a standard smooth atmosphere (Hayes & Latham 1975) for 1.7 km elevation and airmass 1.3, and ‘Sys’ is the total efficiency calculated by multiplying the filter, QE and the atmosphere transmissions. Subscript ‘std’ stands for standard CCD, while ‘hr’ stands for high resistivity (see Figure 1 caption). This table is published in its entirety in the electronic edition of *PASP*. A portion of the full table is shown here for guidance regarding its form and content.

7), while the color terms for the 11 active CCDs are given in Ofek et al. (2012; Table 3). For reference we present the PTF  $R$ -band filter transmission in Figure 1 and in Table 1. Subsequent versions of the PTF photometric catalog will additionally include  $g_{\text{PTF}}$  magnitudes, which will enable straightforward transformation into other magnitude systems.

## 3. CATALOG CONSTRUCTION

Version 1.0 of the catalog was constructed from PTF data taken before November 2011, using the IPAC-PTF pipeline software version identifier (SVID) > 47. For this version of the catalog, we only used PTF fields that were observed with the Mould  $R$  band on at least three photometric nights under good conditions. The terms “photometric nights” and “good conditions” are not well defined and depend on the required photometric accuracy. Here we select only images that have photometric and quality parameters within the ranges specified in Table 2.

A detailed description of the photometric parameters (i.e.,

TABLE 2  
RANGES OF PARAMETERS OF GOOD DATA

Parameter	CCDID	Min	Max	Units
Seeing	all	...	4.0	arcsec
<i>MoonESB</i>	all	-3.0	...	mag arcsec <sup>-2</sup>
<i>APBSRMS</i>	all	...	0.04	mag
$\alpha_{c,R}$	0	0.190	0.244	mag mag <sup>-1</sup>
$\alpha_{a,R}$	0	-0.182	-0.044	mag airmass <sup>-1</sup>
$\alpha_{c,R}$	1	0.175	0.235	mag mag <sup>-1</sup>
$\alpha_{a,R}$	1	-0.177	-0.039	mag airmass <sup>-1</sup>
$\alpha_{c,R}$	2	0.178	0.226	mag mag <sup>-1</sup>
$\alpha_{a,R}$	2	-0.187	-0.037	mag airmass <sup>-1</sup>
$\alpha_{c,R}$	4	0.189	0.249	mag mag <sup>-1</sup>
$\alpha_{a,R}$	4	-0.200	-0.038	mag airmass <sup>-1</sup>
$\alpha_{c,R}$	5	0.200	0.254	mag mag <sup>-1</sup>
$\alpha_{a,R}$	5	-0.198	-0.036	mag airmass <sup>-1</sup>
$\alpha_{c,R}$	6	0.201	0.249	mag mag <sup>-1</sup>
$\alpha_{a,R}$	6	-0.183	-0.027	mag airmass <sup>-1</sup>
$\alpha_{c,R}$	7	0.172	0.238	mag mag <sup>-1</sup>
$\alpha_{a,R}$	7	-0.177	-0.033	mag airmass <sup>-1</sup>
$\alpha_{c,R}$	8	0.181	0.229	mag mag <sup>-1</sup>
$\alpha_{a,R}$	8	-0.175	-0.049	mag airmass <sup>-1</sup>
$\alpha_{c,R}$	9	0.165	0.237	mag mag <sup>-1</sup>
$\alpha_{a,R}$	9	-0.188	-0.038	mag airmass <sup>-1</sup>
$\alpha_{c,R}$	10	0.176	0.260	mag mag <sup>-1</sup>
$\alpha_{a,R}$	10	-0.188	-0.038	mag airmass <sup>-1</sup>
$\alpha_{c,R}$	11	0.188	0.248	mag mag <sup>-1</sup>
$\alpha_{a,R}$	11	-0.189	-0.039	mag airmass <sup>-1</sup>

NOTE. — Min and Max specify the range minimum and maximum, respectively. See text for details.

*APBSRMS*,  $\alpha_{c,R}$ ,  $\alpha_{a,R}$ ) and their distributions is available in Ofek et al. (2012). Here *MoonESB* is the theoretical *V*-band excess in sky surface magnitude (negative number) due to the Moon. This excess is calculated using the algorithm of Krisciunas & Schaefer (1991). *APBSRMS* is the root mean square (RMS) of bright stars of the nightly photometric calibration residuals from the best fit,  $\alpha_{c,R}$  is the *R*-band *r* - *i*-color term coefficient of the nightly photometric solution, and  $\alpha_{a,R}$  is the nightly *R*-band extinction coefficient. The allowed ranges of these parameters (listed in Table 2) correspond to  $\pm 3$  times the one standard deviation<sup>17</sup> from the median value of each parameter over all data taken with a given CCD<sup>18</sup>.

We choose PTF fields<sup>19</sup> that have at least three images taken on three different nights, with the criteria listed in Table 2. The requirement to analyze only fields that were observed on three or more photometric nights is important in order to remove outliers that may be present in the data. For example, if a night was photometric for 90% of the time (e.g., clouds entered toward the end of the night), then our pipeline might claim that the night was photometric, but the calibration of some of the data will be poor. Therefore, in order to get the calibrated source magnitudes, it is important to average the data taken over several photometric nights. Moreover, observations taken on multiple nights allow us to calculate variability and proper motion indicators.

In order to expedite the processing in cases where we have more than 30 images of the same field, we truncated the num-

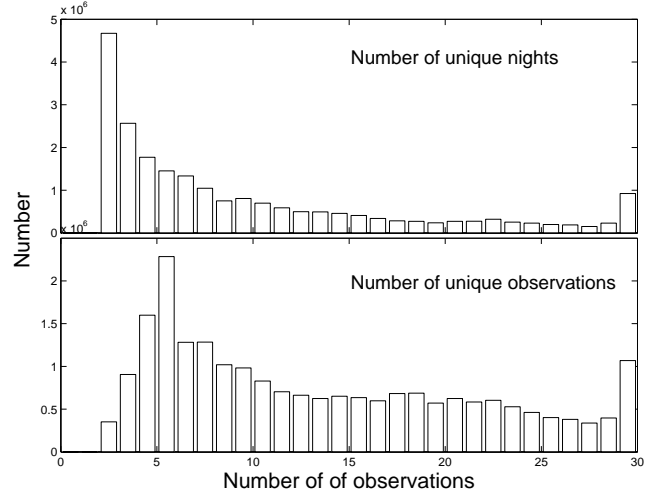


FIG. 2.— Histogram of the number of unique nights (upper panel) and number of unique observations (lower panel) per object in the catalog. The histogram of number of unique observations peaks at six observations, twice of the value at which the histogram of number of unique night peaks. This reflects the fact that until March 2012 for most fields we obtained two observations per night.

ber of images according to the following scheme. If more than 30 images of the same field, taken on less than 30 unique nights, were available, then we selected a single random image from each night. If more than 30 images taken in more than 30 unique nights were available, then we selected only the 30 nights with the smallest *APBSRMS* parameter and selected one image from each one of these nights. Histograms of the number of unique nights and number of unique observations per object in the catalog are shown in Figure 2.

For each set of selected images of a given PTFIELD/CCDID, we matched the sources in all the images against a reference image with a matching radius of 1.5". Here, the reference image was selected as the image of the field with the largest number of sources<sup>20</sup>. We note that in future catalog versions, we intend to use a deep coadd image for each PTFIELD/CCDID as a reference image.

Next, we remove all the measurements that are masked by one of the following flags: source is deblended by SExtractor (Bertin & Arnouts 1996); aircraft/satellite track; high dark current; noisy/hot pixel; containing possible optical ghost; CCD-bleed; radiation hit<sup>21</sup>; saturated pixels; dead pixel; not a number; halo around bright star; dirt on optics. These flags are described in details in Laher et al. (in prep). The remaining photometric measurements are used to calculate the mean photometric properties of each source in the PTF photometric catalog 1.0.

Some of the PTF fields are overlapping in areal coverage. Therefore, some of the sources generated by the process described above are duplicates. We remove duplicate sources and keep the catalog entry which corresponds to the lowest PTFIELD. We also remove all sources fainter than 19 mag. Sources fainter than  $\sim 19$  mag have photometric errors that are larger than the photometric accuracy of this catalog.

#### 4. THE CATALOG

<sup>17</sup> We use the 68 percentile divided by two as a robust estimator for one standard deviation.

<sup>18</sup> The CCD number is designated by CCDID, which ranges from 0 to 11 (CCDID=3 is inoperable).

<sup>19</sup> A PTF field, denoted by PTFIELD, is uniquely associated with a pre-defined sky position.

<sup>20</sup> Typically, this is the image with the best limiting magnitude.

<sup>21</sup> The current radiation hit/CCD bleed flag in the version of the PTF IPAC pipeline used here is not a good indicator for radiation hits.

The PTF photometric catalog is presented in Table 3. The catalog is also available online from the IPAC website<sup>22</sup> and the VizieR service<sup>23</sup>. The following columns are available:

$\alpha_{J2000}$ : The median J2000.0 right ascension over all the images used to derive the photometry.  
 $\delta_{J2000}$ : The median J2000.0 declination over all the images used to derive the photometry.  
 $N_{\text{obs}}$ : Number of images that were used to derive the photometry.  
 $N_{\text{night}}$ : Number of individual nights in which the images were taken.  
 $\text{BestRMS}$ : The best bright-star RMS value (APBSRMS parameter) over all nights used.  
 $R_{\text{PTF}}$ : The median  $R$ -band magnitude in the PTF system (i.e., not color corrected to SDSS) over all epochs.  
 $\Delta R_{\text{PTF}}$ : The error on the median  $R$ -band magnitude as calculated from the range containing 68% of the measurements divided by two (i.e.,  $[\Delta_- R_{\text{PTF}} + \Delta_+ R_{\text{PTF}}]/2$ ).  
 $\Delta_- R_{\text{PTF}}$ : The lower-bound error on the median  $R$ -band magnitude as calculated from the range between the median magnitude and the lower 16-percentile magnitude.  
 $\Delta_+ R_{\text{PTF}}$ : The upper-bound error on the median  $R$ -band magnitude as calculated from the range between the median magnitude and the upper 16-percentile magnitude. By construction the sum of  $\Delta_- R_{\text{PTF}}$  and  $\Delta_+ R_{\text{PTF}}$  gives the 68-percentile range, and it is therefore an estimator for twice the  $1-\sigma$  error.  
 $\mu_{\text{type}}$ : An indicator that can be used to estimate if the source is resolved (e.g., galaxy) or unresolved (e.g., star). This is based on the SExtractor parameters MAG\_AUTO—MU\_MAX. MU\_MAX measures the object surface magnitude in the object’s central pixel. The parameter is normalized such that the median of  $\mu_{\text{type}}$  over the population of sources in the image is zero. Since most sources in PTF images are unresolved (stellar-like), this parameter has a value near zero for unresolved sources, and extended sources will have negative  $\mu_{\text{type}}$  values. Based on our preliminary calibration, there is a  $\sim 2\%$  probability that objects with  $\mu_{\text{type}} < -0.2$  are unresolved (stellar).

$\Delta\mu_{\text{type}}$ : The standard deviation of the  $\mu_{\text{type}}$  as measured over all images used in the processing.

*PTFFIELD*: The PTF unique field identifier.

*CCDID*: The PTF CCD identifier (0 to 11).

*Flag*: A flag that is set to 1 if the 68-percentile range divided by two (i.e.,  $[\Delta_- R_{\text{PTF}} + \Delta_+ R_{\text{PTF}}]/2$ ) is smaller than  $0.03 \times 10^{-0.2(14-R_{\text{PTF}})}$  and is set to 0 otherwise. This flag can be useful in selecting sources for which the photometry is reliable and are likely not strongly variable sources. In the current version of the catalog we list only sources with *Flag* = 1.

The current catalog covers  $11233 \text{ deg}^2$  and its sky coverage is shown in Figure 3. About  $7978 \text{ deg}^2$  are found within the footprint of SDSS-DR8, while  $3255 \text{ deg}^2$  are outside the footprint of SDSS-DR8.

## 5. ACCURACY AND REPEATABILITY

Figure 4 gives contours of objects density in the magnitude-scatter plane, where scatter is the 68 percentile range of the calibrated magnitude measurements divided by two. The thick solid black line shows the error threshold we used to

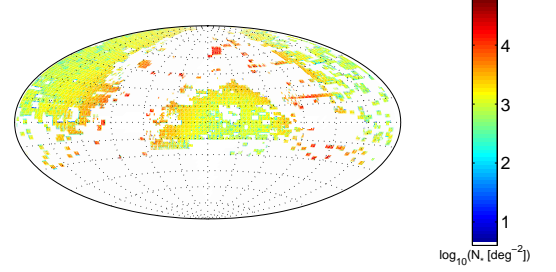


FIG. 3.— Coverage of the PTF photometric catalog 1.0 shown in an equal-area Aitoff projection in equatorial coordinates.  $RA = 0 \text{ deg}$ ,  $Dec = 0 \text{ deg}$  is in the center of the map. The color shading shows the density of stars per  $\text{deg}^2$ , as calculated in a grid of  $0.5 \times 0.5 \text{ deg}^2$  cells on the sky.

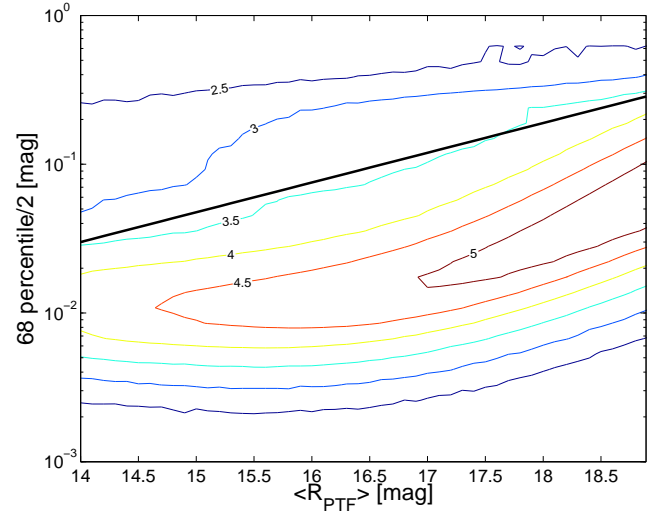


FIG. 4.— The 68 percentile range of the calibrated magnitude measurements divided by two as a function of the median magnitude of each star in the catalog. The contours indicate the  $\log_{10}$  of the density of stars in this plane as calculated in cells of 0.1 mag in the X-axis and 0.1 dex in the Y-axis. The thick-black line shows the error threshold we used to select photometric calibrators (i.e., *Flag* in Table 3). The figure demonstrates that the typical calibration error for bright stars is about 1%–2% and that the errors increase to about 0.06 mag for magnitude  $\sim 19$ . We note that while the 1% error at the bright end is mostly systematic, the  $\approx 6\%$  error at the faint end is mostly statistical (Poisson errors). 2.6% of the stars are found above the solid line (i.e., stars with *Flag* = 0 which are not listed in the current version of the catalog). It is likely that a large fraction of the stars above the solid line are variable stars.

select photometric calibrators (i.e., *Flag* = 1 in Table 3). Figure 5 presents the distribution of the 68 percentile range divided by two of all the stars in the PTF photometric catalog. This histogram suggest that 23.6% (4.3%) of the objects in the catalog have errors worse than 5% (10%). We note that fainter objects have larger photometric (Poisson) errors. Therefore these errors do not represent the floor of systematic errors that can be achieved by using bright stars or many faint stars.

As discussed in §4, some of the sources have duplicate measurements on different PTF fields and/or CCDs. Such duplicate measurements can be used to test the repeatability of the catalog over multiple CCDs. Figure 6 shows the differences between all  $2.1 \times 10^6$  duplicate pairs as a function of

<sup>22</sup> <http://irsa.ipac.caltech.edu/>

<sup>23</sup> <http://vizier.u-strasbg.fr/viz-bin/VizieR>

TABLE 3  
PTF PHOTOMETRIC CATALOG 1.0

$\alpha_{J2000}$ deg	$\delta_{J2000}$ deg	$N_{\text{obs}}$	$N_{\text{night}}$	$\text{BestRMS}$ mag	$R_{\text{PTF}}$ mag	$\Delta R_{\text{PTF}}$ mag	$\Delta_- R_{\text{PTF}}$ mag	$\Delta_+ R_{\text{PTF}}$ mag	$\mu_{\text{type}}$ mag	$\Delta\mu_{\text{type}}$ mag	PTFFIELD	CCDID	Flag
42.532500	−31.087161	23	12	0.022	16.152	0.021	0.017	0.026	0.058	0.095	100111	09	1
42.786188	−31.086008	21	12	0.022	17.172	0.030	0.022	0.037	0.058	0.060	100111	09	1
42.593730	−31.085419	22	12	0.022	18.507	0.063	0.055	0.071	0.106	0.106	100111	09	1
42.525416	−31.081556	23	12	0.022	14.225	0.015	0.017	0.014	0.046	0.072	100111	09	1
42.953363	−31.080395	23	12	0.022	15.286	0.025	0.029	0.022	0.003	0.063	100111	09	1

NOTE. — The table is sorted by declination. See text for column descriptions. This table is published in its entirety in the electronic edition of *PASP*. A portion of the full table is shown here for guidance regarding its form and content.

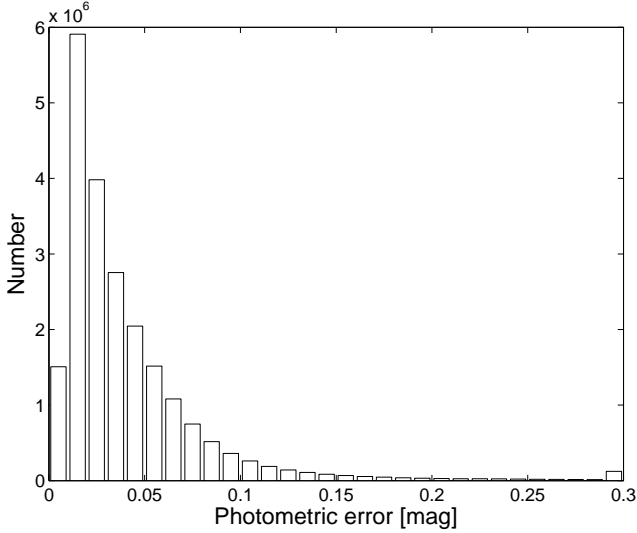


FIG. 5.— Histogram of the 68 percentile range divided by two (robust errors) distribution of all the stars in the PTF photometric catalog. The bins show the number of stars per 0.01 mag bins.

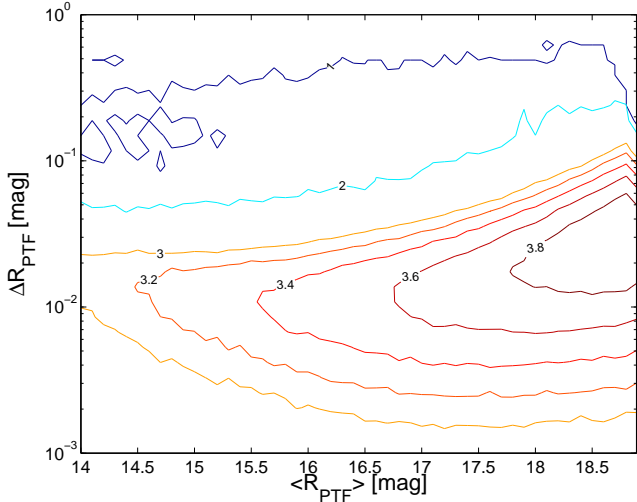


FIG. 6.— The differences between all the duplicate measurements of the same stars taken on different fields or CCDs, as a function of their mean magnitude. This plot is based on about  $2.1 \times 10^6$  duplicate measurements. The contours indicate the  $\log_{10}$  of the density of stars in this plane as calculated in cells of 0.1 mag in the X-axis and 0.1 dex in the Y-axis. The figure demonstrates that the typical repeatability of the photometric catalog is about 1%–2% at the bright end and 3% at the faint end, and that in some cases repeatability of a few mmag is achieved even without applying relative photometry techniques. See additional discussion in Fig. 4.

their mean magnitude. We note that the mean difference between two data points generated from a Gaussian distribution is equal to 1.13 times the standard deviation of the Gaussian. This figure suggests that our photometric calibration does not depend on which CCD in the camera the data were obtained. In the magnitude range 15 to 16, the median repeatability is about 0.01 mag and 95% of the sources have a repeatability better than about 0.03 mag.

## 6. CONCLUSIONS

To summarize, we present a catalog of calibrated PTF *R*-band magnitudes of sources extracted from PTF images. The catalog covers about 28% of the celestial sphere, some of it outside the SDSS footprint. Conversion of PTF *R*-band magnitude to other magnitude systems requires knowledge of the source's color. We note that the scatter in colors of some populations of objects is small enough (e.g., RR Lyr stars, asteroids) that their mean color can be used for conversion. We note that the current version of the catalog is designed as a photometric catalog, rather than astrometric catalog.

Future versions of this catalog will also provide the *g*-band magnitudes, which will allow one to apply color corrections directly, with no assumptions. In future versions, we also plan to include more robust variability information, source morphology and proper motion measurements of individual sources.

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